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Editorial

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The Journal of Hygiene Sciences has made many advances over the years. This issue yet again comes with a commitment to publish a journal of high standards which is devoted exclusively to topics of Microbiology & Disinfection.

Mini Review Section – In continuation with single Cell Proteins. Single Cell Protein (SCP) as coined to describe the protein production from biomass, originating from different microbial sources. Microbial biomass has been considered an alternative to conventional sources of food or feed. Large-scale processes for SCP production show interesting features. A variety of microorganisms and substrate are used to produce single cell proteins. Yeast is suitable for single cell protein production because of its superior **nutritional quality**. The supplementation cereals with single cell proteins, especially yeast, make them as good as animal proteins.

Current Trends Section – In continuation with Disinfection Validation. Fumigation is the process to disinfect the sterile manufacturing and microbiology testing area. Generally fumigation is not required when AHU runs continuously but when the microbial load increases in the controlled area it is controlled and minimized by fumigation of the area.

In Profile – Joseph Lister - "Father of Antiseptic Surgery" His introduction of the antiseptic process dramatically decreased deaths from childbirth and surgery and changed the way the medical industry looked at sanitation and proper hygiene.

Bug of the Month - *L. rhamnosus* was first isolated in 1983 in the intestines of a healthy human subject by scientists Barry Goldin and Sherwood Gorbach, when it was shown to have remarkable tolerance for the harsh acids normally found in the stomach and digestive tract. *Lactobacillus rhamnosus* is a probiotic bacterium that helps eliminate and prevent the growth of harmful bacteria in the intestines. *L. rhamnosus* is also used as a natural preservative in yogurt-based products, where the bacterium attaches to the lining of the intestines, where it encourages the growth of helpful organisms that aid indigestion.

Did You Know? – Sterile pharmaceutical and medical device manufacturing environments require an effective cleaning and disinfection program to maintain aseptic conditions and prevent the microbial contamination of the product. The qualification of the chemical disinfectants used in these environments is extremely important, yet it is often overlooked.

Best Practices - Biomedical waste (BMW) has recently emerged as an issue of major concern not only to hospitals and nursing homes, but also to the environmental and law enforcing agencies, media, and the general public. BMW forms approximately 1%–2% of the total municipal solid waste stream. Health care waste is a heterogeneous mixture, which is very difficult to manage as such. But the problem can be simplified and its dimension reduced considerably if a proper management system is planned.

Ease your mind with a light humour in our Relaxed Mood section…….
So go on, enjoy reading & don't forget to give us your valuable inputs & feedback.

Single Cell Protein (part 2)

Fermentation process: The fermentation process requires a pure culture of the chosen organism that is in the correct physiological state, sterilization of the growth medium which is used for the organism, a production fermenter which is the equipment used for drawing the culture medium in the steady state, cell separation, collection of cell free supernatant, product purification and effluent treatment. A fermenter is the instrument, which is set up to carry out the process of fermentation mainly the mass culture of plant or animal cells. Fermenters can vary in size from laboratory experimental models of one or two litres capacity, to industrial models of several hundred litres capacity. A bioreactor is different from a fermenter as it used for the mass culture of microorganisms. The chemical compounds synthesised by these cultured cells such as therapeutic agents can be extracted easily from the cell biomass. The design engineering and operational parameters of both fermenters and bioreactors are identical. Fermenters and bioreactors are also equipped with an aerator, which supplies oxygen to aerobic processes also a stirrer is used to keep the concentration of the medium the same. A thermostat is used to regulate temperature and a pH detector and some other control devices, which keep all the different parameters needed for growth constant. For the producing and harvesting of microbial proteins cost is a major problem. Such a production even in high rate causes dilute solutions usually less than 5% solids. There are many methods available for concentrating the solutions like filtration, precipitation, centrifugation and the use of semi-permeable membranes. The equipment used for these methods of de-watering is expensive and so would not be suitable for small scale productions and operations. The removal of the amount of water that is necessary to make the material stable for mass storage is not economically viable. Single cell proteins need to be dried to 10% moisture or they can be condensed and denatured to prevent spoilage. The physiological features of microbial organisms recommend the control of the carbon source concentrations, as a limiting substrate, as well as an adequate supply of oxygen for the maintenance of balanced growth under an oxidative metabolic pattern. However, since microbial growth is a time dependent process, it exerts continuous modifications on all process parameters which influence physiology, but most dramatically, over substrate concentration. Therefore, an adequate technology which maintains appropriate growth conditions for a prolonged period of time must be implemented specifically for the purpose of obtaining high yield and productivity values. Batch fermentations are clearly inadequate for the purpose of biomass production, since the conditions in the reaction medium change with time. Fed-batch fermentations are better suited for the purpose of biomass production, since they involve the control of the carbon source supply through feeding rates. However, as the biomass concentration increases, the oxygen demand of the culture reaches a level which cannot be met in engineering or economic terms. Fed-batch culture is still in use for bakers yeast production using well established and proven models. However, they have not been favored for the production of SCP at a large industrial scale. Prolonging a microbial culture by continuous addition of fresh medium with the simultaneous harvesting of product has been implemented successfully in industrial fermentations destined to biomass production. The most commonly used principle has been the chemostat: a perfectly mixed suspension of biomass into which medium is fed at a constant rate and the culture is harvested at the same rate so that the culture volume remains constant. The technical implications of chemostat culture are various and extremely relevant. Production periods as long as six weeks have been implemented in many fungal and yeast. A common problem of industrial fermentations is the profuse appearance of foam on the head space of the reactor, causing reactor pressurization, spillages and contamination hazard. Among the various designs which have been put to effect, the deep-jet fermenter and the air-lift fermenter have been the most successfully applied.

ECONOMIC ASPECTS

For SCP production large-scale fermenters are required. So with high biomass production, high oxygen transfer rates and high respiration rates which in turn increase metabolic heat production and the need of an efficient cooling system ensued. In such a continuous operation for SCP production the economics of this production must be strongly taken into account. The Economics factors that should be taken into account during this fermentation period are: Investment, Energy, Operating costs, Waste, Safety and the Global market.

Substrate costs: The substrate costs are the largest single cost factor. Simplifying the manufacture and purification of raw material can save costs. Moreover the manufacture of raw materials is more economical in larger plants. Factors involved in the raw materials costs are site, raw material production, process capacity of the plant and substrate yield.

Utilities: The energy for compressing air, cooling, sterilizing and drying forms the next most important cost factor. Sites with cheaply available thermal, electrical, fossil or process derived energy are to be preferred.

Capital load: The capital dependent costs are determined, by the cost of the apparatus for the process, the capacity of a plant and the capacity conditions. The main variable here is the size of the plant. Small plants can be profitable only if they include simplifications of processes and material to a considerable degree. The greater expenditure on apparatus in processes with cheap, simple and unpurified raw materials usually does not pay in comparison with more expensive pure substrates with simpler technology. High productivities in fermentation are compensated by the greater expenditure on energy to achieve these productivities, so that optimum can be determined.

Product-specific variables: The process costs arising are covered only by the product produced. The absolute value of the product is governed by the amount of product referred to the costs involved and by the quality of the product. The upgrading of the product may consist of purification and separation of the microbial biomass.

ACCEPTABILITY AND TOXICOLOGY OF SCP

The name of the raw materials used in SCP processes represents the main safety hazard. Toxicology testing of the final product must include short-term acute toxicity testing with several different laboratory animal species, followed by extensive and detailed long term studies. It represents a major scientific and financial investment. The acceptability of SCP when presented as

a human food does not depend only on its safety and nutritional value. In addition to the general reluctance of people to consume material derived from microbes, the eating of food has many subtle psychological, sociological and religious implications.

SCP PROCESSING FOR FOOD

The effective use of microbial protein for human food requires:

- Liberation of cell proteins by destruction of indigestible cell walls
- Reduction of nucleic acid content

Methods of cell wall destruction: The use of microorganism for refined SCP requires not only an adequate amount of specific organism but also an efficient means of disrupting the cell wall. Mechanical integration of cell wall can be carried out either by crushing, crumbling, grinding, pressure homogenization or ultra sonification. Various enzymes or combination of enzymes can be used to digest and disrupt cell wall, either partially or completely. Enzymatic hydrolysis of cell wall is attractive in terms of its delicacy and specificity for only the cell wall structure. It may be used as an alternative to the mechanical disruption, especially for materials that can be inactivated during the mechanical process and it can be performed by endogenous or exogenous enzyme from other microorganisms. However, extensive enzymatic lysis of cells is a very slow process compared to mechanical disruptions. It is possible to use two or more methods for cell disruptions. Combined mechanical and enzymatic degradation of yeast cell wall was tested by. In case of yeast cells they first can be mechanically broken and then incubated with a lytic enzyme. This resulted in the release of a substantial amount of protein mostly from organelles and cell walls. reported enhanced disruption of Candida utilis by enzymatic pretreatment and high-pressure homogenization. Other methods employed for yeast cell breakage include: autolysis followed by enzymatic or alkali treatments, NaCl induced autolysis at different temperature, chemical disintegration using detergent such as sodium dodecyl sulfate or Triton X-100, acid or solvent. The digestibility of yeast and microalgae can be greatly increased by drying at high temperature under certain conditions. However, the heat treatment needed to increase the digestibility of the cells also affects the protein quality and other valuable cell components. Here are the methods for cell disruption:

Non-mechanical methods

- Chemical treatment: acid, base, solvent, detergent
- Enzyme analysis: lytic enzymes, phage infection, autolysis
- Physical treatment: freeze-thaw, osmotic shock, heating and drying

Mechanical methods

- High pressure homogenization
- Wet milling
- Sonification
- Pressure extrusion: french press, freeze pressing
- Decompression (pressure chamber)
- Treatment with grinding particles

Removal of nucleic acids: Several methods have been proposed to reduce nucleic acid levels in SCP. These methods involve chemical and enzymatic treatments. Each has disadvantages both in terms of cost and potential nutritional concern. In 1977, the extraction of nucleic acid by acidified alcohol, salt, acid and alkalis has been proposed. Alkaline extraction of microbial biomass at elevated temperature was also used in 1970. The process resulted in high protein yield with low nucleic acid. However, alkaline hydrolysis of nucleic acid at high temperature causes the formation of potentially toxic compounds such as lysinoalanine. It is an unusual amino acid involved in cross-linking of alkaline protein. Lysinoalanine has been shown to reduce digestion and induce kidneys changes in rats. It also implicated in skin allergy in some persons consuming treated protein. Chemical modification of yeast nucleoproteins with anhydrides has been used to reduce the nucleic acid levels. Yeast contains considerable amounts of endogenous ribonulease activity that is used to hydrolyzed yeast RNA and that cause reduction of nucleic acid level in yeast protein. At the optimum conditions of ribonuclease activity, significant activation of endogenous protease also occurs. This result in proteolytic degradation of protein and thereby, decreases the yield of protein. Alternatively, nuclease has been added exogenously to reduce the nucleic acid content of SCP. Pancreatic ribonuclease (RNase A) and a fungal ribonuclease of Aspergillus candidus strain M16 has been used as the source of exogenous nuclease for the reduction of nucleic acid in the cells of yeast species allowing a substantial reduction of NA. Bacterial or pancreatic nucleases have been also studied for NA removal from yeast cells. Hydrolysis of NA has also been performed by using immobilized enzymes.

CONCLUSION

Single celled protein (SCP) production, referring to the fact that most of the micro-organisms used as producers grow as single or filamentous individuals rather than as complex multi-cellular organism such as plants or animals. Use of microbes in the production of proteins gives many advantages over the conventional method methods. Microbes have shorter generation time, allow easy transformation, utilize many substrates, have no requirements in arable land or any particular season to grow and have the possibility of continuous production in any part of the world. The cell yield varies according to the substrate and type of microorganism.

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Disinfection in agricultural sector

The agricultural disinfectants market, based on application area, is segmented into surface, aerial, and water sanitizing. The surface segment accounted for the largest share in the global agricultural disinfectants market. It helps to remove dirt, dust, manure, and other unwanted materials from the surface and disinfect the wooden, painted, and concrete surfaces in greenhouses and other crop production facilities.

On the basis of end use, the agricultural disinfectants market is segmented into livestock farms and agricultural farms. Disinfectants are used by livestock farmers on newborn animals that are highly vulnerable to diseases and infections, due to their immature immune systems.

Application in the agriculture sector of Silver Hydrogen Peroxide

Silver Hydrogen Peroxide - AN ECO-FRIENDLY AGRICULTURE DISINFECTANT

DISINFECTANT FUNGICIDE VIRUCIDE BACTERICIDE PESTICIDE AID

Synergized reaction of hydrogen peroxide with Nano silver ions in presence of a catalyst in a pressure, pH, and temperature controlled equipment. It is stabilized to prevent quick oxidation and degradation.

Advantages of Eco friendly Colourless, Odourless, Biodegradable Multifunctional Finds a wide range of industrial and domestic applications Broad Spectrum Multimedia sanitation (Air, Water, Soil, Surface) Nontoxic Breaks into water and oxygen and no other toxic residues.

BENEFITS TO GROWER ▪ Saves time, energy and manpower and improves crop economics ▪ Media fumigation can be done even only four hours before plantation ▪ Stable over a wide pH and temperature range ▪ Does not release toxic fumes and harmful gases ▪ Does not require water rinsing after disinfection ▪ Soil does not need to be covered with plastic unlike formalin method Safe and nontoxic to humans Non carcinogenic ▪ Non mutagenic Minimizes the use of harmful fungicides, pesticides, and bactericides ▪ Can be used for regular treatment by drip, foliar sprays, and drenching methods

BENEFITS TO SOIL/ GROWING MEDIA ▪ Destroys all fungi, bacteria, viruses and pest populations in soil or media ▪ Kills even eggs and larval stage of insects-pests ▪ Eco-friendly and biodegradable, breaking down to water and oxygen ▪ Improves soil / media porosity ▪ Adds more oxygen Improves water uptake capacity and capillary action ▪ Does not leave behind toxic residues ▪ Prevents and treats nematode infestations Increases soil/ media life

BENEFITS TO CROP ▪ Increases plant establishment and reduces initial plant mortality ▪ Hasten seed germination and enhance crop growth by boosting fresh root formation It works as a crop activator which enables it to fight against diseases ▪ Denaturation of DNA helps against resistance development Increases both production and marketable yield ▪ Silver has an anti-senescence property which prevents ageing of fruits and vegetables ▪ Helps in Ethylene inhibition Does not produce any phytotoxic effect ▪ Does not cause spotting on flowers and affect taste of fruits and vegetables ▪ Improves lustre of the produce along with extension of shelf-life

METHOD OF APPLICATION ▪ SOIL FUMIGATION ▪ TREATMENT BY DRENCH METHOD ▪ TREATMENT BY DRIP METHOD ▪ FOLIAR SPRAYING ▪ SEED TREATMENT ▪ SEEDLING TREATMENT ▪ SEED BED TREATMENT

This antimicrobial Silver blended with Hydrogen Peroxide finds a wide range of Agricultural Applications SILVER HYDROGEN PEROXIDE

OPEN FIELD CULTIVATION is effective on plants/ crops grown in open fields, i.e., without any additional care/ protection. A complete field sanitation is achieved with the usage of silver hydrogen peroxide in open field cultivation. Commonly grown crops: Apple, Grape, Corn, Potato, Rice paddy, Almond, Watermelon, Radish, and many more

_PROTECTIVE CULTIVATION Protective cultivation is where additional care is taken to save off-season crops, mainly grown for their market yield. Usage of silver hydrogen peroxide is a multimedia sanitizer, and not only it disinfects agricultural areas, it is also used for disinfecting water, and sanitizing the nursery surfaces as well. Commonly grown crops: Apricot, Cucumber, Orange, Pomegranate, Carrot, Banana, and many more

FLORICULTURE Floriculture refers to the division of horticulture with the production of various flowers or other ornamental plants. Silver hydrogen peroxide in effective in treating various floriculture related diseases. Also, the silver in hydrogen peroxide has an anti- senescence property which inhibits the ageing of flowers after cut. Commonly grown crops: Carnation, Chrysanthemum, Rose, Gerbera, and many more

WELL EFFECTIVE AGAINST Fungal Diseases like Powdery Mildew, Downy Mildew, Root & Crown Rot, Botrytis Blight, Damping off and prevents many other Fungal Complexes Pest infestations like Red Mites, Nematodes, even on larvae and eggs of many insects/ pests Bacterial infections like Bacterial Cankers, Leaf Wilting Diseases, Bacterial Spots and Lesions Viral Diseases like Leaf Curling, Leaf Inflammation, and many more

1. Coffee Cultivation: Pests, Diseases and Chemical Disinfection Coffee is the popular beverage name for a species of plants of Coffea genus cultivated for their beans that are used for preparing stimulating drinks. They are small evergreen shrubs with multiple stems and smooth leaves; bear green fruits that become crimson when ripe and normally contain two coffee seeds or beans. The trees can live for 20-30 years. Coffee primarily comes in two varieties, Arabian coffee (C.arabica) and Robusta coffee (C.cenephora) and originates from Africa. They grow in a wide range of soil but generally prefer deep, well draining loam with pH between 5 & 6. Among the coffee producing countries India is the 6th largest producer and exporter of coffee in the world after Brazil, Vietnam, Columbia, Indonesia and Ethiopia with the state of Karnataka accounting for 71% production followed by Kerala at 21% and Tamil Nadu at 5% with an annual production of 8,200 tons. Both Arabica coffee and Robusta are produced in the proportion of 32:68. Indian coffee is unique because it is grown under the canopy of shady trees (a popular Agroforestry practice) making it one of the most eco- friendly crops in India that helps preserve the bio- diversity in the eco-sensitive Eastern and Western Ghats. Coffee production in India steadily rose from 1951 to 2002 after which there was a huge slump for almost a decade owing to drop in global market and prices of coffee, occurrence of drought and outbreak of pests and diseases. Peak production was achieved in 2011-2012 because of responsive measures to mitigate the problems listed above. While the problem with prices and global market was left for economists, the remaining two domains required in-house mitigation. Measures proposed included: ▪ Development of drought tolerant and pest/disease resisting species ▪ Development of irrigation and water retention technologies ▪ Development of pest and disease management methods. The Central Coffee Research Institute has been actively trying to develop new breeds of resistant crops but it has a long way to go and long term programmes for high yield crops and disease resistant strains is a matter of uncertain future right now. Emphasis is laid on the present practices to sustain the production while creating minimal impact on soil health, plant and environment and the need for integrated management of pests and diseases and Eco-friendly biocide disinfectants.

2. The common pest and diseases occurring at coffee cultivations are listed herein: 1) Bacterial Blight: Caused by Bacterium Pseudomonas syringae, the disease can spread over long distances through infected seedlings or via water splash in the field. Symptoms include spots on leaves leading to necrosis on lamina and shoot tips that spread down the branches leading to dead leaves on branches. Only mitigation is use of protective pesticide spray. 2) Cercospora Leaf spot: Caused by Fungus Cercosporacoffeicola, it spreads by wind, water splash and human movement through wet fields. Symptoms include brown spots on foliage and red leaf margins, premature shedding of leaves and infected discolored disfigured berries. Use of pesticides in case of occurrence of disease. 3) Coffee Berry disease: Caused by Fungus Colletotrichumkahawae, very serious disease that spreads within the plantation by air/water/physical contact media and can destroy 80% of the harvest. Symptoms include lesions on green berries, premature fall offs and mummified berries. Protective sprays of pesticides and removal of infected berries are the only remedies. 4) Coffee leaf rust: Caused by Fungus Hemileiavastatrix, it spreads by air and water. Symptoms include lesions on ventral sides of leaves, infection starts from near the bottom of plant and infected leaves drop off premature leaving twigs and defoliated branches. Spraying fungicides and total removal of infected plants seem to be the only remedies. 5) Rootknot Nematodes: Nematodes are wormlike organisms that attack the root system of plants, feeding on the sap. They can form knots in the roots that inhibit the plant from properly feeding. Meloidogyneexigua, M. incognita, M. coffeicola, Pratylenchusbrachyurus, and P. coffeae are the most common species of rootknot coffee nematodes. Symptoms of a nematode infestation are galls, splits, scales and decreased mass in the root system, and chlorosis and defoliation in the upper plant. They are among the most harmful coffee diseases and pests. Application of pesticides seems to be the only preventive option. Pesticides and Fungicides: Copper and its compounds have had a wide-ranging employment in agriculture. It has been used as an active ingredient in various pesticidal and fungicidal formulations to protect crops from major fungal leaf and fruit diseases. Around 6% of world copper production is used in agriculture which directly affects the environment and represents the most important source of copper dissipation directly into soil and environment. It was not before 1880s that accidently copper's fungicidal properties were discovered by French Scientist, Millardet and from 1885 the Cu-based Bordeaux mixture officially became the first fungicide to be used on a large scale world-wide. Copper based fungicides are

3. inorganic compounds that have a multi-site activity with low risk of pathogen developing resistance at any stage; hence popularly used as agricultural pesticides to control fungi, bacteria, and in some cases invertebrates and algae. Following absorption into the pathogen, the metal ions link to various chemical groups present in many proteins and disrupt protein functions. Thus the mode of operation is non-specific denaturation of cellular protein. Copper hydroxide fungicide and Copper sulfate fungicide are the most common salts of copper used as plant fungicides. It is applied in two possible ways: a) Contact Fungicide: These are applied but not absorbed by the plant. They act on surface and prevent infection and germination of the infective propagules of the pathogen. They are sprayed in advance and produce a toxic barrier against pathogen infestation. The biggest limitation is the need to be applied at regular intervals to prevent new growth flushes. b) Systemic Fungicide: These are absorbed through the foliage and roots and transported around the plant in vascular tissues. Thus lower doses and less frequent application is required. They are applied after the infection has occurred to treat symptoms and eradicate the disease mostly during seed treatments or by root dips, in-furrow treatment or soil drenching. They are site specific and hinder particular metabolism functions. They are expensive; sometimes induce defoliation of the plant and often the pathogens become resistant through simple cellular mutations. Even though it's an efficient biocide, copper is still a heavy metal & long years of accumulation in soil and water does have its environmental consequences. Heavy metals tend to accumulate and persist in agricultural soils for a long time. A study conducted by Savithri et al. (2003) in India confirmed significant copper accumulation in surface and subsurface soils due to extensive use of Bordeaux. Horticulture operations with long history of copper fungicide were the main culprits. It is well presumed, heavy metals present in soil may have negative impacts on human health and environment. i) Copper accumulation in soil above threshold values may be responsible for phytotoxicity to higher plant species and associated soil properties. The phenomenon is mainly observed in acidic soils with pH <6; just the type of soil coffee plants prefer. This can disturb the overall productivity of Agroforestry farms present in India ii) Copper biocides have negative effect on soil pH, available phosphorous and organic

matter. When in soil, it binds to organic matter, clay minerals and hydrated metal oxides thus making them unavailable to plants. It has been found to suppress nitrogen fixation by Rhizobium. iii) Earthworms are known as farmer's friend. Their feeding and burrowing activities help regulate organic matter in soil and maintain soil porosity. Copper residues negatively affect soil microbial activity and earthworm population and processes like bioturbidation. Thus depleting soil health.

4. They affect the working and life cycles of naturally occurring bio-pesticides and bio-controls, reduce efficiency of mycorrhizal inoculations. v) Regardless of accuracy of application, copper fungicide spray has the possibility of drift risks & metal contamination in adjacent field damaging non-target sensitive crops and plants, especially in Agroforestry practices. vi) Runoffs from farms containing dissolved copper and copper sulfate toxicity is fatal to aquatic fauna. vii) Long term exposure to copper can cause irritation to nose, mouth and eyes, headaches and vomiting; accidental ingestion of contaminated foods may cause copper poisoning and liver and kidney damage in humans. Silver Hydrogen Peroxide: An eco friendly agricultural biocide Silver Hydrogen Peroxide, as the name suggests is a synergized composition of hydrogen peroxide stabilized with silver ions in the form of silver nitrate or infused Silver Nano particles. Hydrogen Peroxide is a strong oxidizer formed by combination of water with ozone. The bonds between the molecule and oxygen atom are unstable and easily break releasing free oxygen that oxidizes organic matter. Thus H_2O_2 disinfects by oxidizing cell membranes and inner cell structures of pathogens. It is a great biocide; being a strong oxidizing agent. H_2O_2 is stabilized using silver so as to increase its efficacy. Silver acts both as a stabilizer and an activator. In addition to this, silver is shown to have certain disinfectant properties of its own. Addition of silver greatly reduces the quick decomposition of H_2O_2. In presence of silver, the peroxide decomposes only in presence of biological contaminants. The decomposed H_2O_2 oxidizes the cell wall, cell membrane and cytoplasm of the pathogens, the DNA is destroyed thus killing the organism. Silver is known to react with certain proteins in the DNA and act as a biostat, inhibiting further growth of the pathogens. Hydrogen Peroxide and Silver are neither toxic nor produce DPBs upon decomposition. It dissociates producing water and oxygen and the residual silver has been proven to have no ill effects on man and environment. Breaking into water and oxygen, it is world's safest biocide and eco disinfectant. At recommended concentrations of application, it is harmless to the plant and soil biota except pathogens. The most impressive feature of Silver Hydrogen Peroxide is its varied modes of application: → A properly diluted solution of the biocide can be spouted or fumigated on wet soil 12 hours prior to plantation of fresh saplings. This kills most disease causing organisms. → A diluted biocide solution can be directly fed to plant roots by drip lines at stipulated growth periods to prevent re-growth of infectious pathogens. → Soil can be directly drenched with a diluted solution in the early growing season to eradicate most of the pathogens that infect at early stages of growth. → Foliar spraying in the early morning at periodic intervals can keep leaves free from rust and commonly occurring fungal infections → Pruning tools can be sterilized in a diluted solution before operations to minimize infection by contact. → Fresh seeds can be soaked in a diluted solution prior to planting to prevent pathogen infestation during germination stage. → Mature beans can be washed in a dilute biocide solution to remove organic and inorganic residues increasing shelf life and processing operations.

5. Silver Hydrogen Peroxide is by far the best all purpose multi-utility biocide because: ▪ It is effective against all kinds of bacteria, viruses, yeast, mould, nematodes and spore formers ▪ It is Environmentally friendly - practically 100% degradable breaking down to water and oxygen ▪ Does not create odor or alter the taste of beans ▪ Highly effective over long periods even at very high water temperatures and low pH ▪ Has no toxic effect in its diluted state ▪ No carcinogenic or mutagenic effect ▪ Long shelf life: maximum loss of concentration 3% per year ▪ Does not harm other plant parts ▪ Equipment and operation costs are low, can be easily applied without fear of environmental residue.

http://www.marketsandmarkets.com/Market Reports/agricultural-disinfectant-market-89992801.html

http://www.lcbfoodsafety.com/surface-disinfectant.html

http://www.vaneckbv.nl/en/products-and-services/disinfection/-agricultural-sector/

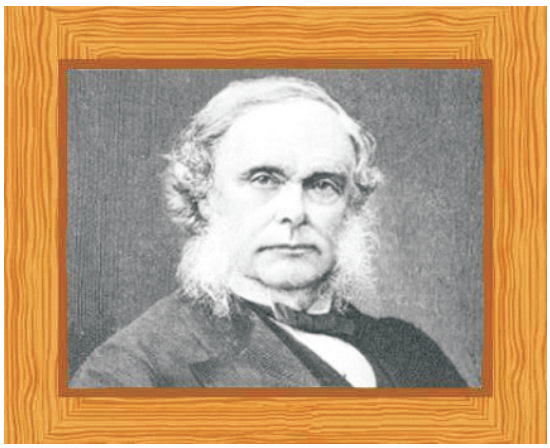
http://aquasolutionsindia.com/agriculture.php

http://www.fao.org/docrep/014/al876e/al87600.pdf

http://www.slideshare.net/roscoeedge06/hydrogen-peroxide-benefits-in-agriculture

Visit us at www.silverhydrogenperoxide.com

Joseph Lister



Acknowledged as the "Father of Antiseptic Surgery", Joseph Lister's contributions paved the way to safer medical procedures. His introduction of the antiseptic process dramatically decreased deaths from childbirth and surgery and changed the way the medical industry looked at sanitation and proper hygiene.

Early Life and Education

Joseph Lister was born on April 5, 1827 in Upton, Essex, England. His father, Joseph Jackson Lister, was not only a wine merchant, but was also an amateur scientist. He was the second among three children.

Coming from a family of Quakers, the young Joseph Lister also attended Quaker Schools in London and Hertfordshire. Quaker Schools put in a great amount of emphasis in the sciences, giving him a strong foundation in what was to be his chosen profession. He observed the first surgical procedure that used anesthesia in 1846. He then attended the University of London where he earned his Bachelor of Arts degree in 1847. Later on, he qualified to become a medical student and eventually earned his Bachelor's degrees in Medicine and Surgery. Because of his exceptional performance, he was awarded with two university gold medals and easily became a Fellow of the Royal College of Surgeons in 1852. He then became the dresser for Professor of Clinical Surgery James Syme in Edinburgh, and eventually became his house surgeon. He married Syme's daughter, Agnes, who became his laboratory partner because of her great interest in medical research.

His Greatest Contribution

Joseph Lister has always been aware that the number of deaths after surgery was not caused by the operation itself, but by what follows after the procedure. Because there was an alarming rate of "ward fever" after surgery, Lister wondered what could be causing this event.

Comparing patients who had simple fractures to those who had compound fractures, he concluded that the infection was coming from the outside, as the problem only occurred to those who had open wounds as compared to those who did not have any flesh wound. Lister started adding hygienic practices before conducting any operation, making sure that his hands were clean and his clothes fresh. At that time, it was common for doctors to walk around covered in blood as this served as a status symbol for them. Lister's untraditional methods were scoffed at.

Looking at research done by Louis Pasteur, a French chemist and microbiologist known for his vaccination, fermentation and pasteurization principles, he agreed with the latter's belief that germs are usually contracted from the air. Because Lister was a wine merchant's son, he knew that wine went bad because the fermentation process was not done properly, and not because germs spontaneously came to life within the wine as evolutionists believed. Applying this thought to open wounds, he knew that the only solution was to find a way to kill the germs before they get the chance to enter the wound, preventing the infection to occur.

Carbolic acid was then being used as an effective disinfectant for sewers. Upon confirming that it was safe to be used on human flesh, Joseph Lister saw it as the solution to the problem. He started using it to wash his hands, as well as the instruments he needed in every operation. He started covering his patients' wounds with a piece of lint covered in carbolic acid. He also devised a machine that sprayed the air with carbolic acid to get rid of airborne germs. He refined his techniques until he had enough proof that everything he did was successful, and went on to publish everything he discovered in a medical journal called The Lancet in 1867.

As expected, it took a long time for other people in the medical field to accept Lister's findings. A lot of them were incredulous at the thought that organisms too small to be seen were causing all the post-operation deaths. Some found it tiring to have to go through the sterilization process before performing an operation. And although some of them tried Lister's methods, majority of them did it incorrectly that their efforts proved to be useless. He was now a Professor of Clinical Surgery in Edinburgh, and he continued to modify his system to achieve better results despite the negative feedback.

It took 12 long years before Lister's system gained widespread acceptance. Those who emulated Lister's example in Munich gained astounding success, with the death rate caused by infection after surgery dropping from 80% to almost zero. The English doctors were among the last to accept the brilliance of Lister's methods, only winning them over when he was appointed as Professor of Surgery in London's King's College Hospital in 1877. By 1879, his findings had gained widespread acceptance around the globe.

Other Achievements

Joseph Lister was the Queen's surgeon for many years, and introduced the use of rubber drainage tubes after trying it on her. He also showed that sterilized materials could be left inside a patient's body as needed and used and left sterilized silver wire inside the body to keep broken bones together. And since the silk thread used in internal stitching causes more damage when pulled out after some time, Lister started using sterilized catgut, as this would eventually dissolve.

Queen Victoria dubbed him Sir Joseph Lister in 1883. He became Lord Lister of Lyme Regis in 1897, and was the first to become a British peer for services to medicine. He was given the Order of Merit in 1902, and was made Privy Councilor.

He became the Vice President of the Royal College of Surgeons and President of the Royal Society. He was also President of the British Association for the Advancement of Science. He helped establish the British Institute of Preventative Medicine in 1891, which was later on called The Lister Institute in his honor.

With all his achievements, he finally retired in 1893, shortly after his wife died in 1892. He still entertained requests for his advice and services from time to time, although he was left a bit melancholic after losing his life partner. Joseph Lister died in Walmer, Kent, England on February 10, 1912 at the age of 84.

JOKES

Farting Is like the song from Frozen.

Work: conceal, don't feel, don't let them know...

At home: Let it go! Let it go! Can't hold it back anymore....

I wish i lived in a world where mosquitoes would suck FAT instead of blood.

Men say that women should come with instructions...

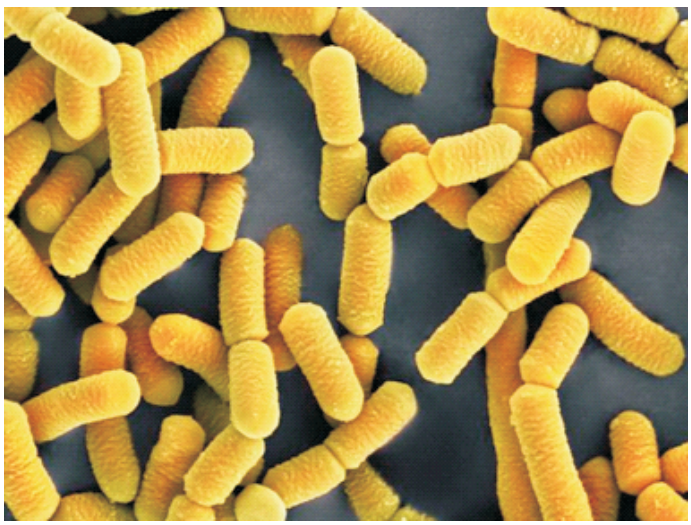
What's the point of that? have you ever seen a man Actually read the instructions?

When you're stressed, You eat ice cream, cake, chocolate and sweets. Why? because stressed spelled backwards is desserts.

LIFE IS SO IRONIC.

It takes SADNESS to know what HAPPINESS is, NOISE to appreciate SILENCE and ABSENCE to value PRESENCE.

Lactobacillus Rhamnosus



Scientific classification

Domain: Bacteria
Phylum: Firmicutes
Class: Bacilli
Order: Lactobacillales
Family: Lactobacillaceae
Genus: *Lactobacillus*
Species: ***L. rhamnosus***

Introduction

Lactobacillus rhamnosus, or L. rhamnosus, is a type of probiotic bacteria. Probiotics, as defined by the Food and Agricultural Organization of the United Nations, are "live microorganisms which, when administered in adequate amounts, confer a health benefit on the host." L. rhamnosus was first isolated in 1983 in the intestines of a healthy human subject by scientists Barry Goldin and Sherwood Gorbach, when it was shown to have remarkable tolerance for the harsh acids normally found in the stomach and digestive tract.. The "GG" in the title of the strain L. rhamnosus GG is derived from the last names of the two scientists. Like other probiotics, L. rhamnosus has properties that are beneficial to the intestinal tract. It is also believed to be of considerable assistance with the immune system, particularly in combating intestinal and urinary tract pathogens. L. rhamnosus is also used as a natural preservative in yogurt-based products, where the bacterium attaches to the lining of the intestines, where it encourages the growth of helpful organisms that aid indigestion. Lactobacillus rhamnosus is a probiotic bacterium that helps eliminate and prevent the growth of harmful bacteria in the intestines. Many consumers may be familiar with lactobacillus probiotics, which are touted today by some yogurt manufacturers as an aid in digestion and in promoting regular bowel activity. In fact, lactobacilli have been used for centuries to aid in the fermentation of dairy products. During the 20th century, researchers began evaluating these organisms and their positive effects on the human body and its ability to naturally ward off disease and infection. The lactobacillus rhamnosus bacterium was first isolated by researchers in 1983, when it was shown to have remarkable tolerance for the harsh acids normally found in the stomach and digestive tract. The following are some of the well noted benefits of Lactobacillus Rhamnosus:

Helps Fight Intestinal Tract Illnesses

According to studies published by Goldin and Gorbach, L. rhamnosus is said to be able to survive the highly acidic conditions of the human stomach, as well as the intestinal tract. It is also believed to be bile-stable. This makes the probiotic highly desirable in its ability to conquer intestinal ailments.

Suppresses Bacterial Infections in Renal Patients

In 2005, it was demonstrated that with patients experiencing kidney-related illnesses, L. rhamnosus is capable of interrupting the gastrointestinal transportation of the variety of enterococcus that is resistant to the antibiotic vancomycin.

Assists in Prevention of Urinary Tract Infections

According to an article published in the November 2009 issue of Renal and Urology News, daily ingestion of L. rhamnosus Gr-1 may be effective in helping postmenopausal women who suffer from chronic urinary tract infections. While dosage of trimethoprim-sulfamethoxazole is considered to be a standard treatment for a UTI, L. rhamnosus is a viable alternative when antibiotic resistance is a consideration. The probiotic seems to be capable of safeguarding the urogenital tract by its ability to excrete biosurfactants. This enables the tract to limit the adhesion of pathogens.

Helps Build a Superior Immune System

While blood cells are certainly a major agent in managing the body's immune system, the gut is also a huge contributor in this area. Because of the ability of L. rhamnosus to survive in extremely acidic environments such as the digestive system, the probiotic can thrive in the gut. L. rhamnosus stimulates the production of antibodies and also assists in the process of phagocytosis, a means by which the body combats dangerous invasive bacteria.

Aids in Dairy Product Digestion Among the Lactose-Intolerant

A 1998 study conducted among dairy-sensitive research subjects showed that the subjects who consumed milk with L. rhamnosus GG did not exhibit the inflammatory response that occurred with the subjects who drank milk without the probiotic. Also, the L. rhamnosus appeared to enhance the immune system in the test subjects in whom the probiotic-enhanced milk did not generate an inflammatory reaction.

Decreases Duration of Diarrhea

Research conducted in 2000 in several European countries indicated that the administration of L. rhamnosus GG to children suffering from rotavirus shortened the duration by at least one day

of the pervasive diarrhea associated with the illness. Another study showed that ingestion lf L. rhamnosus GG was helpful in reducing the extent of diarrhea when it exists as a side effect of antibiotic use to combat H. pylori infections.

Safety of Lactobacillus Rhamnosus:

With the exception of extremely rare occurrences of sepsis in limited groups of patients with serious diseases, such as HIV or AIDS, and in patients with short bowel syndrome. no significant side effects have been shown to exist with the the use of L. rhamnosus. There may be an initial brief period of bloating and gas among subjects taking it for the first time. These symptoms should disappear as the body becomes accustomed to the presence of the probiotic.

Conclusion

Lactobacillus rhamnosus is one of the most widely studied probiotics, noted and valued for its ability to survive and even thrive in the harsh conditions of the digestive and urinary tracts. Multiple clinical trials have determined the bacterium to be especially beneficial in promoting and maintaining digestive tract health. Lactobacillus rhamnosus is extremely well tolerated by men and women, and has been associated with only very rare side effects. Studies have shown that, taken regularly, lactobacillus rhamnosus can be an effective supplement in promoting and maintaining digestive tract health.

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Six Steps to Qualifying Disinfectants

Sterile pharmaceutical and medical device manufacturing environments require an effective cleaning and disinfection program to maintain aseptic conditions and prevent the microbial contamination of the product. The qualification of the chemical disinfectants used in these environments is extremely important, yet it is often overlooked. Disinfectant qualifications require more planning, time and resources than many companies realize. Considering the potential issues and difficulties that could occur while performing these qualifications, contracting an outside lab experienced in disinfectant qualifications may be the most efficient and least painful way to perform this work.

The following six steps provide a framework to assist companies in qualifying the disinfectants used in their environmental cleaning processes. Whether performed internally or by an outside testing lab, they must be addressed.

Step 1: Determine the Test Method

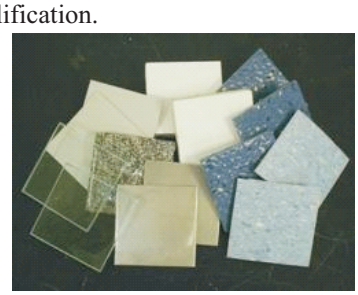
There are a number of methods for qualifying a disinfectant published by the Association of Official Analytical Chemists (AOAC), yet these are for qualifying the disinfectant itself. They are not appropriate for demonstrating the efficacy of a disinfectant within the pharmaceutical, biotechnology, and medical device industries.

Two of the most common methods suggested for disinfection qualification in these environments are:

- Tube method: This method evaluates disinfectants by inoculating dilutions of the disinfectant and determining the microbial reduction. It would most commonly be used as a simple screening to determine the type of disinfectant most effective against a specific set of organisms before performing a comprehensive disinfectant qualification.
- Coupon method: This method is more comprehensive and uses coupons made from actual facility surfaces. The surfaces are inoculated and exposed to the disinfectant. The inoculum is then removed from the surfaces and the $\log_{10}$ reduction determined.

Step 2: Determine the Challenge Organisms

Typically, standard American Type Culture Collection (ATCC) test organisms representing the basic classes of microorganisms (Gram negative, Gram positive, spore-former, fungus) along with actual environmental isolates from the client's facility should be used in the qualification.



Examples of surface sample coupons (polypropylene, vinyl, stainless steel, epoxy coated stainless steel)

Step 3: Determine the Surface Types to be Tested

Each of the construction materials used in the clean room and/or other controlled areas should be tested separately. Examples of common materials are stainless steel, glass, plastic. Normally 2-inch by 2-inch square coupons are used for the qualification.

All coupons must be sterilized or disinfected before use in the qualification. Depending on the material, sterilization may be accomplished through steam, ethylene oxide (EO), or chemical methods.

Step 4: Determine Expiration of Disinfectants

The qualification should replicate the same disinfectant concentration and contact exposure time used in the facility. It also should be performed using the worst-case expiration date for each disinfectant. If a container has a 30-day expiration once opened, and a dilution may be prepared and put into a spray bottle with an expiration of seven days, the efficacy testing should reflect this.

Examples of surface disinfectants

Step 5: Method Validation

Method validation is a critical step to verify that the testing method allows adequate recovery of the challenge organisms in the presence of the disinfectants. Regardless of the method being used, the test system must be inoculated with a low level of challenge organism, with and without (control) exposure to the disinfectant for the designated contact time.

Typically, the recovery of the challenge organisms should be within a factor of two of the positive controls for that organism. If the recovery is not satisfactory, the testing method should be repeated using a different neutralization system and/or additional dilutions.

Step 6: Efficacy Testing

Efficacy testing is the actual testing of the disinfectant. Per the USP General Chapter <1072> Disinfectants, the test system is inoculated with sufficient inoculum to demonstrate at least a two $\log_{10}$ reduction for bacterial spores and a three $\log_{10}$ reduction for vegetative bacteria and allowed to dry. The inoculated system is then exposed to the desired concentration of the disinfectant for the desired contact time.

Swabbing the inoculated coupons

The surviving population in the test system is determined and the $\log_{10}$ reduction calculated. The log reduction data should be used to establish a scientifically supported disinfection program for the client's facility.

Biomedical Waste Management

Definition:
According to Biomedical Waste (Management and Handling) Rules 1998 of India "Any waste which is generated during the diagnosis, treatment or immunization of human beings or animals or in research activities pertaining to or in the production or testing of biological".
Background: Biomedical waste (BMW) has recently emerged as an issue of major concern not only to hospitals and nursing homes, but also to the environmental and law enforcing agencies, media, and the general public. BMW forms approximately 1%–2% of the total municipal solid waste stream.
The human element is found to be far more important than the technology. Almost any system of treatment and disposal of BMW that is operated by well-trained and well-motivated staff can provide greater protection to staff, patients, and the community than an expensive and sophisticated system that is managed by staff who do not understand the risk and the importance of their contribution.

Classification of Bio-Medical Waste
The World Health Organization (WHO) has classified medical waste into eight categories:

- General Waste
- Pathological
- Radioactive
- Chemical
- Infectious to potentially infectious waste
- Sharps
- Pharmaceuticals
- Pressurized containers

Biomedical Waste Management Process
There is a big network of Health Care Institutions in India. The hospital waste like body parts, organs, tissues, blood and body fluids along with soiled linen, cotton, bandage and plaster casts from infected and contaminated areas are very essential to be properly collected, segregated, stored, transported, treated and disposed of in safe manner to prevent nosocomial or hospital acquired infection.

1. Waste collection
2. Segregation
3. Transportation and storage
4. Treatment & Disposal
5. Transport to final disposal site
6. Final disposal

Biomedical Waste Treatment and Disposal
Health care waste is a heterogeneous mixture, which is very difficult to manage as such. But the problem can be simplified and its dimension reduced considerably if a proper management system is planned.

Incineration Technology
This is a high temperature thermal process employing combustion of the waste under controlled condition for converting them into inert material and gases. Incinerators can be oil fired or electrically powered or a combination thereof. Broadly, three types of incinerators are used for hospital waste: multiple hearth type, rotary kiln and controlled air types. All the types can have primary and secondary combustion chambers to ensure optimal combustion. These are refractory lined.

Non-IncinerationTechnology
Non-incineration treatment includes four basic processes:

thermal, chemical, irradiative, and biological. The majority of non-incineration technologies employ the thermal and chemical processes. The main purpose of the treatment technology is to decontaminate waste by destroying pathogens. Facilities should make certain that the technology could meet state criteria for disinfection.

Autoclaving

- The autoclave operates on the principle of the standard pressure cooker.
- The process involves using steam at high temperatures.
- The steam generated at high temperature penetrates waste material and kills all the micro organism
- These are also of three types: Gravity type, Pre-vacuum type and Retort type.

In the first type (Gravity type), air is evacuated with the help of gravity alone. The system operates with temperature of 121 deg. C. and steam pressure of15 psi. for 60-90 minutes. Vacuum pumps are used to evacuate air from the Pre vacuum autoclave system so that the time cycle is reduced to 30-60 minutes. It operates at about 132 deg. C. Retort type autoclaves are designed much higher steam temperature and pressure. Autoclave treatment has been recommended for microbiology and biotechnology waste, waste sharps, soiled and solid wastes. This technology renders certain categories (mentioned in the rules) of bio-medical waste innocuous and unrecognizable so that the treated residue can be land filled. 8.

Microwave Irradiation

- The microwave is based on the principle of generation of high frequency waves.
- These waves cause the particles within the waste material to vibrate, generating heat.
- This heat generated from within kills all pathogens.

Chemical Methods

- 1 % hypochlorite solution can be used for chemical disinfection

Plasma Pyrolysis

Plasma pyrolysis is a state-of-the-art technology for safe disposal of medical waste. It is an environment-friendly technology, which converts organic waste into commercially useful byproducts. The intense heat generated by the plasma enables it to dispose all types of waste including municipal solid waste, biomedical waste and hazardous waste in a safe and reliable manner. Medical waste is pyrolysed into CO, H2, and hydrocarbons when it comes in contact with the plasma-arc. These gases are burned and produce a high temperature (around 1200°C).

Biomedical Waste Management Rules

Safe disposal of biomedical waste is now a legal requirement in India. The Biomedical Waste Management & Handling) Rules, 1998 came into force on 1998. In accordance with these rules, it is the duty of every "occupier" i.e. a person who has the control over the institution or its premises, to take all steps to ensure that waste generated is handled without any adverse effect to human health and environment. It consists of six schedules

Schedule 1. Categories of Bio-Medical Waste

Option	Treatment & Disposal	Waste Category
Cat. No. 1	Incineration /deepburial	Human Anatomical Waste (human tissues, organs, body parts)
Cat. No. 2	Incineration /deep burial	Animal Waste Animal tissues, organs, Body parts carcasses, bleeding parts, fluid, blood and experimental animals used in research, waste generated by veterinary hospitals / colleges, discharge from hospitals, animal houses)
Cat. No. 3	Local autoclaving/ micro waving/ incineration	Microbiology & Biotechnology waste (wastes from laboratory cultures, stocks or specimens of micro-organisms live or attenuated vaccines, human and animal cell culture used in research and infectious agents from research and industrial laboratories, wastes from production of biological, toxins, dishes and devices used for transfer of cultures) Waste Sharps
Cat. No. 4	Disinfections (chemical treatment /autoclaving/micro waving and mutilation shredding	(needles, syringes, scalpels blades, glass etc. that may cause puncture and cuts. This includes both used & unused sharps)

Cat. No. 5	Incineration / destruction & drugs disposal in secured landfills	Discarded Medicines and Cytotoxic drugs (wastes comprising of outdated, contaminated and discarded medicines)
Cat. No. 6	Incineration , autoclaving/micro waving	Solid Waste (Items contaminated with blood and body fluids including cotton, dressings, soiled plaster casts, line beddings, other material contaminated with blood)
Cat. No. 7	Disinfections by chemical treatment autoclaving/micro waving& mutilation shredding.	Solid Waste (waste generated from disposable items other than the waste sharps such as tubing, catheters, intravenous sets etc.)
Cat. No. 8	Disinfections by chemical treatment and discharge into drain	Liquid Waste (waste generated from laboratory & washing, cleaning , house-keeping and disinfecting activities)
Cat. No. 9	Disposal in municipal landfill	Incineration Ash (ash from incineration of any bio-medical waste)
Cat. No. 10	Chemical treatment & discharge into drain for liquid & secured landfill for solids	Chemical Waste (chemicals used in production of biological, chemicals, used in disinfect ion, as insecticides, etc)

(Source- The Bio Medical Waste (Management and Handling) Rules, 1998)

Schedule II: Colour Coding and Type Of Container for Disposal of Bio-Medical Wastes
Schedule III: Label for Bio-Medical Waste Containers/Bags

Recommendations

1. For the use of incinerator Training should be given to some number of persons from staff.
2. Specific fund should be allocated for the use of incinerator.
3. Every hospital should have special boxes to use as dustbin for bio-medical waste.
4. Bio-medical waste should not be mixed with other waste of Municipal Corporation.
5. Private hospitals should also be allowed to use incinerator, which is installed, in govt. hospital. For this purpose a specific fee can be charged from private hospitals.
6. Special vehicle i.e. bio-medical waste vehicle should be started to collect waste from private hospitals and private medical clinics and carry it up to the main incinerator.
7. As provided by bio-medical waste rules, the whole of the waste should be fragmented into colours due to their hazardous nature.
8. Bio-medical waste Management Board can be established in each District.
9. Either judicial powers should be given to the management board or special court should be established in the matters of environment pollution for imposing fines and awarding damages etc.
10. Housekeeping staff wear protective devices such as gloves, face masks, gowned, while handling the waste.
11. There is biomedical waste label on waste carry bags and waste carry trolley and also poster has put on the wall adjacent to the bins (waste) giving details about the type of waste that has to dispose in the baggage as per biomedical waste management rule. Carry bags also have the biohazard symbol on them.

CONCLUSION

Medical wastes should be classified according to their source, typology and risk factors associated with their handling, storage and ultimate disposal. The segregation of waste at source is the key step and reduction, reuse and recycling should be considered in proper perspectives. We need to consider innovative and radical measures to clean up the distressing picture of lack of civic concern on the part of hospitals and slackness in government implementation of bare minimum of rules, as waste generation particularly biomedical waste imposes increasing direct and indirect costs on society. The challenge before us, therefore, is to scientifically manage growing quantities of biomedical waste that go beyond past practices. If we want to protect our environment and health of community we must sensitize ourselves to this important issue not only in the interest of health managers but also in the interest of community.

http://www.cwejournal.org/vol7no1/need-of-biomedical-waste-management-system-in-hospitals-an-emerging-issue-a-review/
http://www.scopemed.org/▪mno=49217
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3180941/table/T2/

Highlights of the coming issue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